BELLCOMM, INC.
955 L'ENFANT PLAZA NORTH, S.W. WASHINGTON, D. C. 20024

SUBJECT: Incorporation of the Meteoroid Impact and Erosion Experiment, T-017, into the AAP Experiment Program - Case 630

DATE: April 14, 1969

FROM: F. F. Tomblin

MEMORANDUM FOR FILE

[redacted]

I. INTRODUCTION

The Meteoroid Impact and Erosion experiment (T-017) consists primarily of 10 vicor glass panels which will provide information on meteoroid size distribution from craters left by meteoroid impact. This experiment was originally combined with experiment T-021, Meteoroid Velocity, on a pallet to be deployed on the airlock module during the AAP-2 mission. The weight of these combined experiments was in excess of 200 lbs. Because of the heavy weight, both T-017 and T-021 were recommended for rejection from the AAP program at the 69-1 MSFEB meeting.

A considerable portion of the weight for the T-017/ T-021 experiment pallet was required for support of T-021 alone. The experiments have now been separated. The principal investigators for T-017, R. E. Flaherty and H. A. Zook, have redesigned this experiment into a 30 lb package which may be deployed and retrieved by EVA. We consider here only the T-017 experiment integration problems into the AAP experiment program.

II. EXPERIMENTAL CONSTRAINTS

This experiment must be deployed in such a way that it faces above the earth's horizon looking into space not greatly obstructed by any portion of the spacecraft. To get meaningful statistics it must be deployed for at least two months.(1) No thrusters or jets should impinge upon the glass surfaces as they may cause cratering which would be indistinguishable from meteoroid impacts.

III. INCORPORATION INTO THE AAP PROGRAM

The AAP-2 launch is the only reasonable time to carry this experiment. It should be deployed on the first EVA of AAP-2 and retrieved on the AAP-3A EVA. The reasons for this schedule are as follows:

1. Reasons in favor of an AAP-2 launch-AAP-3A retrieval:

   a) Because of weight reductions in T-027 (Contamination Measurement) of about 30 lbs, weight is now available on AAP-2.

b) Although the first EVA schedule is crowded, the time required for deployment is insignificant compared to other EVA tasks.

c) The 4th airlock truss is available for mounting which would allow the experiment to look back along the S-IVB toward the solar array during the POP phase of AAP-2. Some slight canting off the + Y axis of the airlock may be necessary to avoid looking at the solar array edgewise. This is not a serious problem as the array is at least 10 feet from the proposed mounting point. During the gravity gradient stabilized mode operative in the storage phase, the experiment would continuously look normal to the plane of the earth's horizon.

d) The EVA schedule for the 3A mission is very light and retrieval at that time is opportune.

e) The time between the first EVA on AAP-2 and the AAP-3A EVA has not been scheduled but it will undoubtedly be in excess of the two month minimum exposure time.

f) The experiment could not be left until the AAP-3/4 mission because of possible contamination by thrusters during LM/ATM docking. The PI is not sure if contamination would be serious at this time.(1) Also a 5th EVA from the airlock hatch would be required, as all ATM EVA's are performed from the LM.

2. Reasons against deployment and retrieval on AAP-3/4, assuming an LM or ATM rack mounting:

a) Only 34 days are currently planned between the first and last EVA on the 3/4 mission. This is not adequate for the PI's desires.

b) Because of the solar orientation of the ATM, a fixed orientation of the panels such that they continuously look above the horizon would be almost impossible. This would cut deeply into an already short effective exposure time.

c) Additional constraints on field of view are imposed by the Saturn I workshop, LM, ATM, solar panels, outriggers and sunshields.

d) Location on LM is impractical because environmental control subsystem radiators may be blocked. In addition, requirements for EVA translation about the RCS plume deflectors and requirements for an additional complex EVA work station at other locations on the LM impose serious crew safety requirements for any additional LM mounted obstacles.

e) Return payload for the AAP-3 CM is marginal and not improving.

IV. DETAILS OF AIRLOCK MOUNTING

The airlock module deployable experiments D-021 and D-022 have been moved from the configuration planned when the T-017/21 pallet was planned for AAP-2. D-021 now occupies the 3rd truss originally occupied by the pallet. However, the 4th truss is available for mounting.

The experiment is in the form of ten 6" x 16" panels extending 5 feet outward in the deployed position. Because the S-IVB is larger in diameter than the airlock module and the S-IVB solar fin is mounted in the + Y direction, the experiment should not be deployed looking directly back toward the S-IVB, but at some angle (20° - 30°) with respect to the normal plane of the workshop long axis.

V. SUMMARY AND CONTINGENCY FOR A COMBINED 3A-3/4 MISSION

The AAP-2 deployment of the T-017 experiment with retrieval on AAP-3A is ideal for obtaining sufficient experimental data with little possibility of thruster contamination. Space and weight are available for both launch and return payload. Studies should be conducted on thruster contamination even though the surfaces mounted on the airlock will be looking away from the thruster exhaust.

If the 3A mission is combined with the 3/4 mission with a CSM re-visit then some consideration should be given to LM mounting. A LM/ATM mount may then be appropriate. The possibility of thruster contamination to glass surfaces during CSM docking and departure must then be seriously considered. Details of the possibilities for ATM mounting are outlined in Attachment 1.

F. F. Tomblin

1015-FFT-caw

Attachments
Reference
Memo to F. F. Tomblin from
S. H. Levine, April 4, 1969

REFERENCE

(1) Telephone Conversation with H. A. Zook, MSFC PI for T-017, April 1, 1968.

ATTACHMENT 1

BELLCOMM, INC.
955 L'ENFANT PLAZA NORTH, S.W. WASHINGTON, D. C. 20024

SUBJECT: Comments to the Proposed Incorporation of the T017 Micrometeoroid Experiment on the AAP-4 LM/ATM

DATE: April 4, 1969

FROM: S. H. Levine

Mr. F. F. Tomblin:

Per your request, I am submitting the following comments for your consideration in evaluating the technical feasibility and scientific merit of flying the T017 experiment mounted somewhere on the LM/ATM module.

1. Launch stowage is currently a major problem on AAP and is receiving a great deal of attention at the NASA OMSF field centers. Command Modules (CM) on AAP are all in trouble with launch stowage equipment lists that identify stowage requirements far in excess of the CM's stowage capability. These stowage deficits currently amount to 1100 pounds of equipment on both AAP-1 and AAP-3A and 800 pounds of equipment on AAP-3. We can, therefore, look to the LM which currently has some payload weight margin (volume limited) to absorb some of these problems. It is therefore suggested that any consideration of stowage of this total experiment (deployment device and samples), prior to usage, be abandoned, regardless of its low weight and volume. Consideration should be limited to permanently mounting the experiment somewhere on the exterior of the spacecraft, with detection samples in place on the retracted boom during AAP-4 launch. This would eliminate some astronaut activity on the first EVA and additional stowage problems in the CM or LM. Care should be taken to incorporate the necessary experiment covers (possible added weight) to prevent damage from spacecraft debris, contamination, and RCS propulsion effects (deposition, erosion and thermal) on these folded panels, prior to deployment.

2. It is suggested that all deployment schemes proposed, other than the DeHavilland scheme, be rejected because of the following reasons:

a. MSC will reject any device that requires stored energy (i.e., springs, pressure vessels, pyrotechnics, etc.) for deployment by an extravehicular crew member. This is a crew safety criterion that has been emphatically made clear on AAP. It should be pointed out that the concept identified as the Spring Loaded Boom Deployment scheme could, with the elimination of the springs at the hinged joints and usage of friction-held hinges, be acceptable to MSC, inexpensive and easy to deploy.

b. Remote deployment, from the interior of the spacecraft, is sure to be opposed by MSFC because of the requirement for additional controls and displays (already tight), power, telemetry measurements (already tight), logic and circuitry, etc., in support of deployment device activation (i.e., pyrotechnics, actuators, motors, etc.)

3. EVA is currently scheduled, on the AAP-3/4 mission, on T+17 days, T+27 days, T+40 days and T+51 days, where T-0 represents the launch of AAP-3. For the alternate and backup AAP-3/4 mission, EVA is scheduled for T+16 or 17 days and T+27 days. At best, on the nominal mission this experiment would collect data for 34 days of operation and on the alternate mission for 10 days of exposure. This may not be compatible with the Principal Investigator's desires. Should trouble arise during the nominal mission, there is a likelihood that with some ATM film data already retrieved and onboard the spacecraft, abandonment of later EVAs and film/sample retrieval would have to be considered.

4. Proper locationing of this experiment would cause little interruption of EVA timelines and could improve the balance of EVA activities since retrieval of detector panels would be performed on the last EVA day when ATM cameras are retrieved but not replaced (i.e., the lightest EVA work load).

5. Any location that could be found for this 16-inch by 36-inch micrometeoroid impact/erosion sampler would have some solid angle field of view limitations due to the Saturn I Workshop (SIWS), LM and ATM rack configuration (i.e., solar array wings, outriggers, sun shields, etc.)

6. Should room for such a device be found external to the LM/ATM (a note of caution - space is very marginal on the ATM), it should be placed in close proximity to an EVA work station (one is currently planned for location at the front hatch on the LM and another at the +Y/+Z axis [mass properties axes] of the ATM rack). Care should be taken to locate the device where it will not impede EVA astronaut translation or retrieval of ATM film. Location of this device on the LM does not appear to be practical from the standpoint of blocking the view to space of LM environmental control subsystem radiators, the requirement for EVA translation around RCS plume deflectors (crew safety consideration), and the requirement for an additional complex EVA work station at other locations on the LM.

7. Consideration of EVA surface sample tethers/tether rings and the effect of these on experiment weight would have to be assessed.

8. Candidate locations for this experiment on ATM could be:

a. the +Y outrigger (mass properties axis) of the ATM rack in a manner similar to the mounting on the Airlock Module outrigger shown in the letter Integration of Experiment T017 with AAP-2, dated March 19, 1969, by Robert E. Flaherty and Herbert A. Zook, P.I.s for AAP Experiment T017,

b. the ATM rack lower ring truss, and

c. the solar shield truss.

Further analysis would be required to determine how these locations would affect the ATM thermally (possible blockage of view to space of ATM canister radiators, shading of the cluster, etc.), and structurally (truss load bearing capacity, ease of mounting, etc.). I don't believe these will present any problem.

9. It should be pointed out that CM return payload capacity is currently marginal and not improving. Further study would have to be performed to determine if return of these samples in the CM on AAP-3 is feasible.

10. Additional questions that require answers are:

a. What is the size of the retracted unit?

b. What is the weight of the return samples? Is the total panel framework with the detectors returnable, or must the detector frames be handled piecemeal?

c. Are there any special handling requirements? Can they be stacked? Will a box be required for stowage and retrieval?

d. Environmental constraints require identification, (particularly launch acceleration, vibration, shock, thermal, etc.).

Summary

I would discourage consideration of mounting this experiment on ATM because:

a. ATM development is well enough along that introduction of this unit will most certainly impact design and advanced analysis,

b. astronaut activity to support ATM is currently far too complex and it is felt that elimination of tasks rather than introduction of new ones should be an objective,

c. return payload problems in the CM.

Although I personally feel that the experiment appears to have scientific merit and that we will accrue additional benefits from demonstrating man's ability to retrieve divers experiments on a space station by EVA techniques, I believe that this experiment more appropriately belongs on AAP-2. AAP-2 EVA tasks are less complex and more in line with what would be required to support this experiment, view factors to space are better, and susceptability to contamination is reduced. It is conceivable that if this experiment were used on AAP-2, other sampling surfaces could be mounted on this device on revisit missions, with increased versatility, little effort and virtually no cost impact or that longer duration micrometeoroid sampling (three months or more) could be performed.

S. H. Levine

1024-SHL-jd

S. H. Levine

Copy to
Messrs. D. L. Forsythe - NASA/MLA

T. H. Crowe
M. S. Feldman
D. R. Hagner
J. R. Porter
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From: F. F. Tomblin

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ABSTRACT

Recommendation is made for AAP-2 deployment of the T-017 meteoroid impact and erosion experiment. The experiment could then be retrieved on AAP-3A. This experiment cannot be deployed and retrieved on the 3-4 mission because insufficient exposure time is available between the first and last EVA's on this mission.